

AFRL-ML-WP-TR-1999-4083

**DURABLE/CLEANABLE COATING
TECHNOLOGIES PROGRAM**

DEVELOPMENTAL ACTIVITIES



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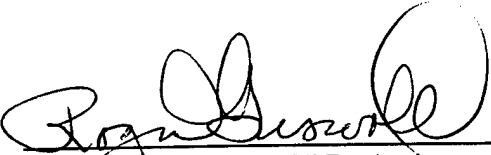
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13. ABSTRACT (Maximum 200 words) The U.S. Air Force is interested in obtaining aircraft coatings that exhibit superior performance properties when compared to currently available coating systems. The current technology uses low gloss, polyurethane coatings to provide color and environmental protection for its aircraft. These topcoats must maintain their low gloss and color properties after years of environmental exposure. Two characteristics, namely durability and cleanability, have been difficult to achieve in commercially available coatings. The three Task E vendors did not achieve significant improvements in durability or cleanability as desired. At the end of their approximately 6-month research and development efforts, which was cut slightly short due to budget constraints, only Hentzen coatings prepared a product that performed marginally better than other formulations submitted for characterization at Battelle Columbus. It is possible that better formulations may have been achieved if additional time was provided to the vendors. USM reported that, if they had been able to develop the coating system based on fluoropolymer technology, significant improvements may have been achieved. Likewise, Hart Polymers felt that had they been allowed additional time for research, color, gloss and solvent resistance issues would have been resolved.				
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1. Summary

The three Task E vendors did not achieve significant improvements in durability or cleanability, as desired. At the end of their approximately 6-month research and development efforts, which was cut slightly short due to budget constraints, only Hentzen coatings prepared a product that performed marginally better than other formulations submitted for characterization at Battelle Columbus.

It is possible that better formulations may have been achieved if additional time was provided to the vendors. USM reported that, if they had been able to develop the coating system based on fluoropolymer technology, significant improvements may have been achieved. Likewise, Hart Polymers felt that had they been allowed additional time for research, color, gloss and solvent resistance issues would have been resolved.

2. Introduction

The U.S. Air Force is interested in obtaining aircraft coatings that exhibit superior performance properties when compared to currently available coating systems. The current technology uses low gloss, polyurethane coatings to provide color and environmental protection for its aircraft. These topcoats must maintain their low gloss and color properties after years of environmental exposure. Two characteristics, namely durability and cleanability, have been difficult to achieve in commercially available coatings.

AFRL established Task E in the delivery order to develop new approaches in topcoat chemistry and formulations that would extend the life and reduce maintenance costs of paint for Air Force applications. A second objective was to meet strict new environmental requirements for hazardous air pollutants and VOC content.

To fulfill the requirements of Task E, SAIC sought proposals for the development of an innovative coating component(s), formulation, or chemistry that would provide *significant* improvement over current Air Force topcoats in durability or cleanability. Other important properties were identified in the *Durable, Cleanable Coatings Requirements Document* (Attachment 1).

3. Project Schedule

SAIC established the Task E schedule (Table 1).

Table 1. Task E Project Schedule

Task	Performed By	Completion Date
Send out RFP to eligible vendors	SAIC	Dec 1997
Receive proposals	Vendors	Jan 1998
Select Task E vendors	SAIC	Feb 1998
Establish subcontracts with Task E vendors	SAIC/Vendors	April 1998
Submit coating samples for testing	Vendors	Nov 1998
Complete testing on coating samples	Battelle	Dec 1998
Submit final report to AFRL	SAIC	Mar 1999

Battelle Laboratories provided initial testing for desired properties. This work was accomplished in conjunction with the second phase of testing for Task A-D of the same AFRL delivery order.

4. Vendor Selection

SAIC prepared a request for proposal (RFP) to develop innovating paint concepts. A copy of the RFP is attached (Attachment 2). The RFP was sent to 12 vendors. SAIC received six (6) proposals from the following organizations:

- Air Products
- Dr. Shelby Thames, University of Southern Mississippi
- Hart Polymers
- Hentzen Coatings
- Pflaumer Brothers
- TJF Technical Solutions

SAIC reviewed each proposal package and evaluated the proposals based on a firm set of criteria:

- Innovation (40 points)
- Technical Approach (40 points)
- Capabilities (20 points)
- Cost (Pass/Fail)

A copy of the evaluation form is attached (Attachment 3).

Based on the anticipated project funding, the top three Task E vendors were selected. Each contract had a contract ceiling of \$100,000 with a period of performance of nine months. A summary of each of the Task E vendor's activities is provided in the following section.

5. University of Southern Mississippi (USM)

5.1 Proposal

USM proposed to react fluoropolymers, polyester polyols, and reactive silicon materials with polyisocyanates to form a durable, cleanable coating. USM suggested that the use of fluoropolymers and reactive silicon materials would yield a highly durable coating. In order to avoid the higher gloss found with such coatings, they proposed two techniques. First, they would use phase-separated polymers, and second, they would prepare the formula by minimizing the reduced pigment volume concentration (PVC_r). In this way, USM hoped to formulate a coating that would achieve superior performance in durability and cleanability with a very low gloss. USM's starting point for formulation can be summarized as follows:

Binder/resin: Desmophen (polyester polyol)

Desmodur (polyisocyanate)

Fluoropolymers

Reactive silicon materials

Pigments: Synthetic silica

Wollastonite

Diatomaceous silica

Zeeospheres

Solvent: Oxsol 100

Cyspar

Additives: UV absorbers

Hindered amine light stabilizers

Crosslinking agent

5.2 Progress

In May 1998, USM worked on the experimental design, planning for the execution of the established experiments, and obtaining materials for project execution. By the end of June, they began working with reduced pigment volume concentration (PVC_R) concept with polyurethane polymers synthesized from aliphatic polyester polyols and fluoropolyols crosslinked with polyisocyanates, and extender pigments.

By the end of September 1998, USM developed a formulation comprising a polyester-isocyanate binder and a combination of pigments. This formulation included a combination of three extenders. USM reported that the combination of extenders and polymeric binder acted synergistically to provide the low gloss at low extender loadings. They conducted several tests, including cleanability, impact resistance, and fluid

resistance to several oils and reagents, and concluded that their formulation was performing significantly better than the control coating.

In October 1998, USM's was devoted entirely to developing military-specification compliant coatings from fluoropolymers. They chose to repeat the extender combination of the polyester formulation for the fluoropolymers and formulated various coatings accordingly. They also completed fluid resistance tests on the polyester topcoats formulated previously.

5.3 Final Product

USM submitted the polyester topcoat initially developed for this project. They did not have adequate time to work on the development of a coating based on fluoropolymer technology. USM felt that the fluoropolymer coating would have significant improvements in durability and cleanability ratings. Table 2 below describes the results of the coating that USM submitted for testing.

Table 2. Initial Test Results - USM

Test	Results	Comment
Gloss	3.9	Fair
Delta E	4.5	Fair
Cleanability (%)	71	Fair
Cleanability (deltaE)	7	Poor
MEK Rubs	100	Very Good
Water Soak (120F, 96hrs)	Several 1-2 Size	Poor
GE Impact (RT)	>60	Very Good
GE Impact (-60F)	2	Poor

6. Hart Polymers

6.1 Proposal

Hart Polymers planned to react an "amine hydrogen curative complex" (AHCC) and polyester polyols with an aliphatic polyisocyanate to achieve a durable, cleanable coating. The AHCC is a primary amine that reacts with the isocyanate before it can react with water. In addition, the polyurea formed from this reaction increases the flexibility and durability of the coating. After selecting the optimal combination of polyols and AHCCs, Hart Polymers proposed to evaluate potential pigments for chemical and acid resistance. Hart Polymers proposed to evaluate a variety of isocyanates to obtain linear cross-linking with the polyester polyols. Finally, they proposed to select additives to achieve the proper functional characteristics (flow, viscosity, etc.). Hart Polymers proposed the following formulation:

Binder/resin: Polyester polyols

AHCC

HDI

IPDI

TMXDI

Pigments: Barium sulfate

Titanium dioxide

Aluminum trihydrate

Zinc stearate

Solvent: Water

6.2 Progress

In May 1998, Richard Hart of Hart Polymers reported that they had selected an initial formulation that contained polyester polyols, corrosion resistant inorganic pigments, and that was successfully cross-linked with aliphatic polyisocyanate (Bayer Desmodur N-3300). This formulation contained no volatile organic compounds (VOCs) and was tested for basic properties and initial results appear positive.

By the end of June 1998, Hart prepared two formulations. The first formulation consisted of polyester polyols, amine hydrogen curative complexes, water, flow aids, defoamers and corrosion resistant pigments. The corrosion resistant pigments selected included flumed silica, titanium dioxide and alumina trihydrate. These components were cross-linked with 100% solids aliphatic polyisocyanate. Hart reported that the results were fairly good, but the gloss level was unacceptable and needed further development. The second formulation involved a new resin model based on a pre-reacted polyol and aliphatic polyisocyanate self-cross-linking system. After this resin was prepared it was further formulated with corrosion resistant pigments and hydrogen curative complex with water being the only solvent in the system. This was cross-linked with a non-isocyanate

hardener (cyclo-aliphatic epoxy in water). Hart felt that the properties of zero-VOC, low gloss, good adhesion, good solvent resistance, good flexibility, and a working time of 4 hours could be achieved.

In June 1998, SAIC staff visited Hart Polymers. Hart demonstrated the first formulation described above, but it was clear that he had not achieved the flatness desired and that the solvent resistance was unacceptable.

By September 1998, Hart was concentrating on the optimizing the level of polyester polyols required for the system. He felt their system was going to meet most of the requirements, with the exception of flatness. He also planned on testing new corrosion resistant pigments based on aluminum silicate with hopes of lowering the gloss.

6.3 Final Product

Hart Polymers was the only vendor that submitted a zero-VOC product. However, his sample fell short in several key areas, namely color, gloss, water soak, and solvent resistance. Table 3 below presents the initial test results of the coating that Hart Polymers submitted to Battelle Columbus for characterization.

Table 3. Initial Test Results - Hart Polymers

Test	Results	Comment
Gloss	24.9	Very poor
Delta E	1.5	Good
Cleanability (%)	90	Very Good
Cleanability (deltaE)	3	Good
MEK Rubs	15	Very poor
Water Soak (120F, 96hrs)	Several 2-3 size blisters	Very poor
GE Impact (RT)	>60	Excellent
GE Impact (-60F)	2	Good

7. Hentzen Coatings

7.1 Proposal

Hentzen Coatings proposed to use a binder of polyisocyanates, aldimines, fluoropolymer polyols, and polycarbonate polyols to produce a coating with outstanding durability and weatherability. This binder promised to provide rapid cure times and extended pot life. The proposed benefit of this formulation was that the aldimines would retard the cross-linking process until after the coating is applied. Hentzen Coatings proposed to use an approach similar to that used in the preparation of their Chemical Agent Resistant Coating to introduce pigments and produce a very low gloss coating.

Binder/resin: Polyisocyanates

Aldimines

Fluoropolymer polyols

Polycarbonate polyols

Pigment: Polymeric beads

PTFE

Mica

Solvent: Not specified (presumably not aqueous)

Additives: Not specified

7.2 Progress

In May 1998, Hentzen reported that they had selected the basic formula design established in their Zenthane® Plus technology. Hentzen's objective was to determine the pigment combinations needed to match the color and gloss required. They had no problems achieving the color required. They had difficulties with achieving gloss and sheen requirements. They tried different combinations of organic beads, but found that sole use of polymeric beads did not produce satisfactory results. They investigated inorganic flattening agents with good results.

By August 1998, Hentzen was having trouble obtaining the fluoropolymer resin as they had hoped. Instead, they focused their attentions on polycarbonate polyols and polycaprolactone polyols. Hentzen felt that either of these polyols, combined with the best available polyisocyanates, would produce excellent low gloss films. They built parallel formulations, but had difficulty keeping the VOC levels below 2.8 pounds/gallon. They continued to evaluate their experimental formulations for desired properties, as identified in the Air Force Requirements Document.

In November 1998, Hentzen completed their formulation and prepared a two-component sample for submission to Battelle for testing. A copy of their technical specification sheet is attached (Attachment 4).

7.3 Final Product

Hentzen was not able to get the VOC content from 3.5 pounds per gallon to 2.8 pounds per gallons or less, as they had hoped. However, the Hentzen product produced the best results overall of all three Task E vendors. Table 4 below presents the initial test results for the coating that Hentzen Coatings submitted to Battelle Columbus for testing.

Table 4. Initial Test Results - Hentzen Coatings

Test	Results	Comment
Gloss	4.3	Good
Delta E	1	Good
Cleanability (%)	80	Good
Cleanability (deltaE)	4.9	Good
MEK Rubs	100	Very good
Water Soak (120F, 96hrs)	No Blisters	Very good
GE Impact (RT)	2	Poor
GE Impact (-60F)	0.5	Poor

Hentzen Coatings was the only coating formulation of the three vendors for Task E selected for limited full-scale testing by Battelle Laboratories.

ATTACHMENT 1

**DURABLE, CLEANABLE COATING REQUIREMENTS
DOCUMENT**

Durable, Cleanable Coatings Requirements Document

Requirements

Topcoat candidates submitted must meet the following General and Environmental Resistance Requirements to be considered replacement candidates for currently available polyurethane coatings.

A. General Requirements.

1. Federal Standard 595a color number 36251 gray shall be the only color number formulated and tested in this program. Topcoat materials shall be compatible with all classes and types of MIL-P-85582, TT-P-2760, and MIL-P-23377 primers. To verify the requirements listed herein, topcoat materials shall be tested over primer conforming to NSN 8010-01-424-2797, Courtaulds 513X423C.
2. As applied to the work surface, these topcoats shall comply with 1998 NESHAP requirements and shall contain no EPA-17 chemicals. Currently, volatile organic compound (VOC) contents are limited to a maximum of 420 gm/l at point of use.
3. Topcoats evaluated shall be formulated to be applied principally with HVLP (high velocity low pressure) spray equipment. They should also be compatible with airless electrostatic, air-assisted airless electrostatic, airless and air-assisted airless spray equipment.
4. Materials shall be applied and comply with all requirements herein under the conditions of 50° F to 110° F and a relative humidity range of 30% to 90%.
5. These topcoat materials shall be easily stripped by complete coating system removal by all current methods in use at U.S. Air Force Air Logistics Centers (ALCs).
6. An optional "summer/winter" solvent package may be proposed to meet the requirements of items A.2. and A.4.

B. Environmental Exposure Resistance

1. Weathering resistance. Following exposure to the weathering conditions specified below, the color stability shall be demonstrated by a ΔE less than or equal to 0.3. The coating system must also meet as many of the desired properties in section F after weathering exposure.

Durable, Cleanable Coatings Requirements Document

<u>Test</u>	<u>Test Condition</u>
2.1 Xenon Arc	1,500 hours exposure
2.2 Carbon Arc	1,200 hours exposure
2.3 UV Condensate (UVB)	90 cycles with each cycle consisting of 8 hours UV exposure at 160° F followed by 4 hours condensation at 120° F
2.4 Outdoor exposure	45° angle of exposure, facing south for 2 years with an interim check after 1 year in Key West, Florida.

2. Cleanability. After contamination with a method per MIL-C-85285 and cleaning with MIL-PRF-85285C standard cleaner and MIL-C-87937 (type I and type III, B&B Regal), the topcoat shall have a measured ΔE less than 0.3 and a minimum cleaning efficiency of 90% per MIL-PRF-85285C. The coating system must also meet as many of the desired properties in section F after cleanability testing.

Desired Properties

Topcoat candidates submitted must meet as many of the following desired properties as possible to be considered replacement candidates for currently available polyurethane coatings.

C. Wet Properties

1. Drying time. The drying time for the topcoat shall not exceed 2 hours for set-to-touch or re-coat and shall not exceed 6 hours for dry-to-tape. Under standard conditions of A.4. the coating materials shall be cured to withstand flight conditions and water resistance defined in paragraph F.2 after a topcoat cure time of 48 hours in the conditions of A.4.

2. Wet edge time. The topcoat wet edge time shall be a minimum of 10 minutes and a maximum of 12 minutes under standard conditions defined in A.4.

3. Pot life. After mixing, the viscosity shall be such that the coating system can be applied with the application equipment defined in A.3. after 4 hours. The

Durable, Cleanable Coatings Requirements Document

topcoat material defined herein shall meet all the requirements of this document at the end of the 4-hour pot-life with the exception of paragraph C.4.

4. Viscosity. The initial viscosity of the as-mixed components (if applicable) shall be low enough to be applied by methods defined in A.3. The appropriate initial viscosity shall be noted on the label by batch so that this parameter can be used for acceptance testing prior to production use.

5. Shelf life. The components in this system shall meet all of the requirements herein after a 1-year shelf life, with a possible extension for an additional 1-year life, for a total shelf life of 2 years when stored in warehouse conditions at a temperature range of 32° F to 110° F.

6. Freeze-Thaw Stability. A topcoat shall meet all requirements herein after five freeze-thaw cycles. One freeze-thaw cycle shall be 16 hours at 15° F \pm 5° F, followed by 8 hours at room temperature 75° F \pm 10° F.

D. Physical Film Properties

1. Flexibility. Using GE impact method, the flexibility shall be at least 40%. The reverse impact shall be a minimum of 60 in-lbs. These requirements shall be met initially and following all resistance tests specified in section B and F.

2. Low temperature flexibility. The low temperature flexibility of the topcoat shall exhibit no cracking when bent over a 1" mandrel at -60° F \pm 5° F initially and following all resistance tests specified in section B and F.

3. Adhesion. Adhesion of the topcoat to the primers listed in A.1. shall be a minimum of 1,500 psi. This will be determined via flat-wise tension in accordance with ASTM D5179 as modified by CTIO initially and following all resistance tests specified in section B and F.

4. Rain erosion resistance. Rain erosion resistance of the coating system on aluminum leading edge airfoils at 500 mph and 1 inch per hour simulated rainfall shall be a minimum of 15 minutes.

5. Surface roughness. Surface roughness less than 70 micro-inches.

6. Sealant compatibility. All topcoat materials shall be compatible with MIL-S-8802, MIL-S-81733, MIL-S-83430, and their AMS counterparts. Compatibility shall be demonstrated via 100% cohesive failure of the sealant when tested per ASTM D 5179 as modified by CTIO.

Durable, Cleanable Coatings Requirements Document

E. Optical Film Properties

1. Color. Federal Standard 595a color number 36251 gray shall be the only color number formulated and tested in this program.
2. Gloss. Specular gloss measurement for the topcoat shall be less than 3 at 60° and 85° as received and less than 5 at 60° and 85° after cleaning per B.2 and following all resistance tests specified in section B and F.
3. Infrared reflectance. The total hemispherical (specular and diffuse) near infrared reflectance measured at an incident angle of 10° to 20° off the normal and compared to barium sulfate 100% as a standard shall conform to the following limits for camouflage colors initially and following all resistance tests specified in section F:

Wavelength (nanometers): 1000-2500

Maximum reflectance (%): 10% average solar reflectance at sea level

4. Hiding power. The contrast ratio of the coating system at a specified dry film thickness shall be greater than 0.95, 72 hours after application.

F. Resistance Properties

1. All resistance properties stated below, except for water resistance, shall be achievable after 72 hours air cure under the standard conditions defined in A.4. Water resistance shall be achievable after 48 hours air cure under the standard conditions defined in A.4.
2. Fluid resistance. The topcoat shall have an initial pencil hardness in the range of 2H, H, F, and HB. Following the fluid immersions specified below, the pencil hardness shall change no more than 1 pencil hardness from the initial reading. Impact flexibility, gloss after cleaning, color after cleaning, and cleanability requirements, as stated above, shall not change. In addition, stain resistance for all of the conditions specified below shall be demonstrated by a ΔE no greater than 0.3:

<u>Fluid</u>	<u>Immersion time</u>	<u>Fluid temperature</u>
MIL-H-83282	30 days	Ambient
MIL-H-83282	7 days	150° F
MIL-H-5606	7 days	150° F

Durable, Cleanable Coatings Requirements Document

MIL-T-83133 (JP-8)	30 days	Ambient
Distilled water	4 days	120° F
MIL-L-23699	24 hours	250° F

3. Mar resistance. A minimum of 120 grams weight shall not produce an unrecoverable marking of the topcoat surface when viewed at 100x.

4. Humidity resistance. Following exposure in a humidity chamber for 30 days at 120° F \pm 5° F and 95% \pm 5% relative humidity, the coating system shall exhibit no blistering and meet the original requirements of adhesion, impact flexibility, gloss, mar resistance, and shall exhibit no more than one pencil hardness change as defined in F.2. Testing shall be accomplished 4 hours after removal from the humidity chamber.

5. Heat resistance. Following exposure to 300° F in air for 4 hours, the coating system shall meet the original requirements of adhesion, impact flexibility, gloss, mar resistance, corrosion resistance and a ΔE of no more than 0.5.

6. Abrasion resistance. Using a Taber Abraser with a CS-17 wheel and a 1,000 gram load, the coating system shall not exceed 100 milligrams of weight loss in 10,000 cycles.

ATTACHMENT 2

TASK E REQUEST FOR PROPOSAL

REQUEST FOR PROPOSAL

NEW CONCEPTS FOR DURABLE, CLEANABLE TOPCOATS

PROJECT OBJECTIVE: Develop innovative component, chemistry and/or formulation techniques for durable, cleanable topcoats for Air Force aircraft.

BACKGROUND: The U.S. Air Force utilizes low gloss, polyurethane coatings (topcoats) that provide color and environmental protection for its aircraft. These topcoats must maintain their low gloss and color properties after years of environmental exposure and maintenance. Commercial paint suppliers have had difficulty in supplying paints that achieve adequate durability and cleanability. New, unique approaches in topcoat coating chemistry and formulation are sought in order to extend the life and reduce the costs of maintaining topcoats for Air Force applications.

To assist the research and development community, the Air Force has prepared a document that defines key performance parameters for a topcoat based upon F-15 and A/OA-10 aircraft requirements. This document, the *Durable Cleanable Coatings Requirements Document*, is included as Attachment A to this request for proposal (RFP). This document provides specific technical guidance for the development of new concepts in topcoat formulations, including descriptions of the various test methods to be used and performance requirements for those tests.

SAIC seeks a proposal for the development of an innovative coating component(s), formulation, and/or chemistry that will meet the requirements specified in the *Durable, Cleanable Coatings Requirements Document*. SAIC and the Air Force realize that it may be difficult to meet all of these requirements in one formulation. At a minimum, a new concept must provide *significant* improvement over current Air Force low gloss topcoats in durability or cleanability. Durability is primarily measured in terms of weathering resistance (as specified in Section B of the *Durable, Cleanable Coatings Requirements Document*). Cleanability is primarily measured in terms of cleaning efficiency (as specified in Section B of the *Durable, Cleanable Coatings Requirements Document*). The remaining sections of the *Durable, Cleanable Coatings Requirements Document* specify additional desired properties for aircraft topcoats. Ultimately, the Air Force seeks a topcoat that will meet all of those additional properties, and proposals that demonstrate the capability of achieving success in those areas will be viewed as superior to proposals that do not.

In addition to cleanability and durability, the U.S. Air Force faces a difficult technical challenge in complying with strict new environmental requirements for aircraft topcoats. The developed topcoat must meet the following requirements: (1) an upper limit of 420 g/l for the organic hazardous air pollutant (HAP) and VOC content and (2) contain no EPA-17 chemicals after application (see Attachment B for a list of the EPA-17 chemicals). However, more stringent regulations reducing the allowable amounts of HAPs and VOCs in topcoats are expected in the next 5 to 7 years. New concept

topcoats must incorporate environmental compliance considerations as part of the formulation objective.

PROJECT REQUIREMENTS: The successful offeror(s) will be responsible for performing the following tasks:

1. Develop an innovative paint component(s), chemistry, or formulation that meets the requirements of Section A and B of the *Durable, Cleanable Coatings Requirements Document*. A significant (order of magnitude) improvement in cleanability and/or durability over conventional topcoats is the objective of this program.
2. Provide SAIC with a list of the ingredients of the formulation including specific chemicals, trade names, and amounts (by weight/volume). This formulation will be delivered to the Air Force under contract. No proprietary formulations are allowed. The Air Force will require limited rights to the formulation, so that it may be used on U.S. government equipment, including Air Force weapon systems. The offeror will retain the rights to the formulation for other, non-government uses.
3. Perform testing sufficient to demonstrate the improvement in durability and/or cleanability performance of the proposed component(s), formulation, or chemistry. The offeror must test the formulation for weathering resistance and cleanability, as specified in Section B of the *Durable, Cleanable Coatings Requirements Document*.
4. Submit test results to SAIC.
5. Submit a sample of the formulation for qualitative analysis. These samples will be used to demonstrate the basic properties of the coating. The sample should be supplied both as a liquid and as a coated panel, according to the following instructions:
 - 5.1. The liquid sample should be supplied as a 1-quart kit.
 - 5.2. A coated aluminum panel, approximately 12 inches by 12 inches should be prepared and submitted.
 - 5.3. The following documentation should be supplied with the sample submission: (1) The name of the product, (2) the lot and batch number of the product, (3) the date of manufacture of the product, and (4) a material safety data sheet (MSDS).
 - 5.4. Additional test samples may be needed to evaluate the performance of the formulation. If additional test samples are required, they will be requested as part of a separate effort.
6. Attend three one-day project status meetings in Dayton, Ohio. Provide a status briefing to SAIC and government representatives at these meetings.

EVALUATION CRITERIA: Evaluations will be graded on a 100-point scale and a single pass/fail criterion. The following factors will be used to evaluate all proposals:

1. **Innovation.** The offeror must demonstrate that his/her concept provides a significant improvement on the existing topcoat in terms of durability and/or cleanability. New topcoat concepts must meet one or both of these requirements. A higher score will be given for proposals that provide substantial improvement for a single requirement (e.g., durability) than to proposals that provide only slight improvement over both requirements. Strong consideration will be given to those concepts that are truly innovative and that offer significant improvements over current topcoat performance (i.e., high-risk, high-payoff). Re-formulations of existing, proprietary polyurethane topcoats will be scored lower. Formulations that consider environmental performance (low VOC and HAP, no EPA-17 constituents) as described under *Background* will be scored higher. Formulations that achieve the basic requirements (substantially improved durability or cleanability) and that also achieve significant improvements in other areas will be graded higher.(40 points)
2. **Technical Approach.** The offeror must provide a complete description of the technical approach that will be used to accomplish the project objective. The emphasis for this evaluation factor is on technical quality and the offeror's potential to achieve the stated project objective. The offeror must demonstrate a complete and reasonable plan for developing and testing a new paint formulation. The potential to execute the work is indicated by the offeror's ability to provide a comprehensive, logical, orderly, and concise plan that clearly indicates all tasks and milestones. (40 points)
3. **Capabilities.** The offeror should state the credentials and capabilities of the company and individuals that will be assigned to this project. The evaluation will consider the offeror's experience in preparing innovative coating formulations and the relationship between past performance and the proposed concept. Greater emphasis will be given to those offerors that can provide specific descriptions of applicable qualifications, capabilities, and experience that demonstrate the capability to meet the stated project objective. This may include whether the offeror has the in-house expertise and equipment to perform all required tasks. If the offeror proposes the use of a subcontractor to conduct tests, the capabilities of the subcontractors will also be evaluated. (20 points)
4. **Cost:** This criterion is a pass/fail factor. The offeror must be capable of fulfilling the technical requirements described above within the not-to-exceed (NTE) ceiling (see "Estimated Cost" below). All tasks identified in the offeror's Technical Approach must have cost estimates identified, along with a basis of the estimate (i.e., labor rates, assumptions, etc.).

PERIOD OF PERFORMANCE: If selected, the offeror will have 9 months to complete the technical requirements described above from the date of award. The offeror should submit a detailed schedule showing specific milestones and significant events for the project.

ESTIMATED COST: SAIC estimates the cost to develop a new topcoat formulation and provide the requested amount of paint, test coupons, and required reports to be no greater than \$100,000. This figure is inclusive of all costs required to complete the project, such as labor, materials, subcontracts, and travel. For the purpose of the estimate, the offeror should expect to travel to three project meetings in Dayton, Ohio for

one day each. SAIC plans to establish a subcontract with the selected offeror(s). Upon notification of award, SAIC will enter into negotiations with the offeror to establish a subcontract and determine the exact method of payment and the basic terms and conditions of this agreement.

FORMAT: The proposal must be provided in the following format:

1. **Outline.** The proposal should contain the following sections:
 - 1.1. *Cover Page.* The cover page should identify the title of the proposed project (NEW CONCEPTS FOR DURABLE, CLEANABLE TOPCOATS), the name of the company, the name of the company's point of contact (one name only), the point of contact's address, phone/fax numbers, and e-mail address. (1 page)
 - 1.2. *Technical Objective.* State concisely the research objective for the project. (Together with Technical Approach, 4 pages)
 - 1.3. *Technical Approach.* List the tasks to be performed. Articulate the approach for each task. Describe how the formulation will be prepared. Discuss the physical and chemical characteristics of the formulation that will give the coating the desired properties. For the tests, provide details about experimental design and methodology. Provide a milestone chart identifying tasks, milestones, time frames, and deliverables. (Together with Technical Objective, 4 pages)
 - 1.4. *Corporate Capabilities.* Provide adequate information that demonstrates the offeror's ability to perform the tasks identified in "Project Requirements." Give a brief description of the facilities and equipment that will be used in performance of this project. If used, identify subcontractors and provide enough detail to determine their capabilities in performing tasks under this project. Do not provide corporate brochures, pamphlets, or other marketing materials. (1 page)
 - 1.5. *Research Team.* Describe the research team. Identify the project manager and other key performers. Provide a brief description of each individual's capabilities and role in this project. One- to two-page resumes for up to three individuals can be attached, and will not be counted in the page limit. (1 page)
 - 1.6. *Cost Estimate.* Provide cost estimates for each task in the technical approach and a summary of the overall project costs. Include a breakout of labor and other direct costs. Labor costs should be given as an hourly rate times a specified number of hours. (1 page)
2. **Page limits, fonts, etc.** The Cover Page shall be one page. The Technical Objective and Technical Approach sections together shall be no longer than four pages. The Corporate Capabilities, Research Team, and Cost Estimate sections shall be no more than one page each. Proposals received with one or more sections in excess of the specified lengths given above will NOT be evaluated past the specified length for the section(s). One page constitutes one side of an 8½ by 11-inch sheet of paper. The proposal should be single-spaced, double-sided, with one inch margins on 8½ by 11-inch paper. The preferred fonts are 12-point Arial or Times New Roman and all font sizes used must be at least 10

points. Resumes, if provided, are limited to three two-page, double-sided attachments. All proposals must be printed on paper with a minimum of 20 percent post-consumer recycled content.

3. **Submission procedures.** Please submit four copies of the proposal for evaluation. Mail copies of the proposal to:

Science Applications International Corporation

ATTN: Gary Chiles, M/S R-4-3

11251 Roger Bacon Drive

Reston, Virginia 20190

ATTACHMENT 3

TASK E VENDOR EVALUATION FORM

Summary

	Score	Points Available
Innovation		40
Technical Approach		40
Capabilities		20
Cost		P/F
Total		100, P/F

Overall Comments:

Innovation

The offeror must demonstrate that his/her concept provides a significant improvement on the existing topcoat in terms of durability and/or cleanability. The offeror will score points here if they have described a technology that is not "the same old coating". The offeror will get more points for radically new ideas, but these ideas may be much harder to accomplish in practice. The proposal must explain how to actually accomplish the tasks described.

	Low	_____	High
Provides substantial improvement in durability (10 points)			
Provides substantial improvement in cleanability (10 points)			
Is innovative (i.e., not a re-formulation of existing, proprietary polyurethane topcoats) (10 points)			
Considers environmental performance (low VOC and HAP, no EPA-17 constituents) (5 points)			
Achieves significant improvements in other areas. (5 points)			

Total Score: _____/40 points

Comments: (Provide details on how score was calculated.)

Technical Approach

The offeror must provide a complete description of the technical approach that will be used to accomplish the project objective. This criterion is very important. The proposal should clearly provide the details that leaves the reader with the feeling that the offeror could actually carry out the work described. The proposal should describe the technical benefits of the approach taken. The proposal should also demonstrate that the offeror has thought this through and written down a plan for accomplishing the work. This may include management approaches, technical tasks, communications strategies, alternatives if dead ends are reached, and descriptions of milestones.

	Low				High
Technical quality of proposal. Does the plan present a clear picture of the technical goals and provide a map of how the offeror will achieve the goals? (20 points)					
Demonstrates potential (ability) to achieve the stated project objective. How will the offeror know that the goal is achieved? Clearly defined criteria for success, alternatives if the goals aren't achieved. (10 points)					
Provides a comprehensive, logical, orderly, and concise plan that clearly indicates all tasks and milestones. Has the offeror provided a good project schedule with tasks and milestones? (10 points)					

Total Score: _____/40 points

Comments: (Provide details on how score was calculated.)

Capabilities

The offeror should state the credentials and capabilities of the company and individuals that will be assigned to this project. The evaluation should pay particular attention to the tasks the offeror will do and what tasks will be subcontracted or pushed back to the Air Force.

	Low				High
Demonstrates experience in preparing innovative coating formulations and the relationship between past performance and the proposed concept. Past production of coatings (10 points)					
Provides specific descriptions of applicable qualifications, capabilities, and experience that demonstrate the capability to meet the stated project objective (e.g., in-house expertise, equipment, etc.). Current production/testing/formulation capabilities (10 points)					

For each SUBCONTRACTOR listed in the approach, evaluate with the above criteria.
Attach a separate score sheet, if required.

Total Score: _____/20 points

Comments: (Provide details on how score was calculated.)

Cost

This criterion is a pass/fail factor. The pass/fail allows for a little flexibility. Evaluate if the offeror has explained clearly why the project will cost what it will cost. If the cost differs significantly from the NTE, then the offeror must describe why it differs.

	Pass	Fail
Proposed approach less than not-to-exceed (NTE) ceiling.		
Cost estimates are identified, along with a basis of the estimate (i.e., labor rates, assumptions, etc.).		

Total Score: _____ (Pass/Fail)

Comments:

ATTACHMENT 4

HENZTEN COATING'S TOPCOAT TECHNICAL SHEET



TECHNICAL BULLETIN

BRM2176A/BRM2176B Gray Flat Durable/Cleanable Zenthane® Plus*, Fed. Std. 595 Color #36251

PRODUCT DESCRIPTION

Zenthane® Plus is Hentzen Coatings' trade name for a unique line of two component moisture curing polyurethanes. These are 3.5 VOC compliant. This system exhibits an exceptionally long pot life. Zenthane® Plus polyurethanes are known for their ability to form films free of micro-blisters, especially in hot and humid conditions.

HANDLING & STORAGE

The containers should be stored away from direct sunlight and heat. Freezing is not harmful if reheated gently to room temperature prior to use.

PHYSICAL CHARACTERISTICS

BRM2176A Gray Flat Durable/Cleanable Zenthane® Plus - Component A:

Weight Per Gallon:	10.13 lbs. \pm .25
Weight Solids:	67.2% \pm 1.0
Volume Solids:	52.3% \pm 1.0

BRM2176B Clear Activator - Component B:

Weight Per Gallon:	6.92 lbs. \pm .25
Weight Solids:	49.0% \pm 1.0
Volume Solids:	48.0% \pm 1.0

Admixed Characteristics:

Mixing Ratio:	4:1 by volume
Weight Per Gallon:	9.50 lbs. \pm .25
Weight Solids:	64.5% \pm 1.0
Volume Solids:	51.4% \pm 1.0
VOC:	< 3.5
Viscosity:	< 30" @ #4 Ford
Theoretical Coverage - sq. ft./gl. @ 1.0 mil dry film thickness:	824
Useable Pot Life:	Several days if properly protected from moisture

*Patent Pending

Cure Schedule - Air Dry @ 77°F & 50% Relative Humidity:

Dust Free:	2 - 4 hours
Dry to Handle:	4 - 8 hours
Full Cure:	2 - 4 days
Gloss 60°:	< 5 @ 2 mil DFT
Gloss 85°:	< 5 @ 2 mil DFT

ENVIRONMENTAL REPORT

Volatile Content (Wt.%):	35.5
Organic Volatile Content (Wt.%):	35.5
Water Content (Wt.%):	0.00
Water Content (Vol.%):	0.00
VOC Minus Water:	< 3.5

DIRECTIONS FOR USE

Apply over MIL-C-23377G or equivalent primer. Component A should be thoroughly agitated prior to blending. After agitating, mix 4 volumes of Component A to 1 volume of Component B and mix the two Components well. The material is now ready to use. Apply this material with conventional spray equipment. No reduction is necessary. If reduction is needed, 00053SST-1 from Hentzen or urethane grade ketones, esters, and aromatic hydrocarbons can be used. By using Zenthane® Plus Accelerator 04655CHD, the dry times of Zenthane® Plus can be dramatically reduced with only slight loss of pot life. Please consult the technical bulletin for the accelerator for more details.

PRECAUTIONS & SAFETY

- Do not spray without adequate ventilation.
- Read all container labels.
- Read Material Safety Data Sheet.

CLEAN-UP

Clean equipment immediately after use with 00053SST-1 or suitable urethane grade solvent.

November 2, 1998